U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION II

Emergency and Remedial Response Division
290 Broadway, 18th Floor
New York, New York 10007-1866

MEMORANDUM

TO: Tanya Mitchell, RPM
        ERRD/SPB/Mega Projects Section

FROM: Lora M. Smith, Risk Assessor
        ERRD/PSB/Technical Support Section

        Michael Scorca, Hydrologist
        ERRD/PSB/Technical Support Section

DATE: August 28, 2012

RE: **Addendum to the Final Remedial Investigation Report, December, 2011
        Raritan Bay Slag, Old Bridge/Sayreville, New Jersey**

The following language was developed by the project team to amend the Human Health
Risk Assessment for Raritan Bay Slag.

Unacceptable Risks from Biota
Unacceptable risks to current/future adult and child anglers consuming fish or hard clam
at the Raritan Bay Slag site were demonstrated in the risk assessment. All unacceptable
risks were due to the presence of inorganic arsenic.

The total estimated cancer risk for adult anglers consuming fish was $2x10^{-4}$. While
slightly above the acceptable risk range if interpreted as $1x10^{-6}$ to $1x10^{-4}$, this calculated
risk is within EPA's discretionary interpretation of the NCP risk range (10^{-6} to 10^{-4}). The
total estimated cancer risk range for children who consume fish caught by adult anglers
($6x10^{-5}$) is within EPA's acceptable risk range. The total non-cancer HQ for adult
anglers consuming fish (1) is at EPA's threshold of unity while the total non-cancer HQ
for children (2) is above EPA's threshold of unity.

The total estimated cancer risk for adult anglers consuming hard clam is $2x10^{-4}$. While
slightly above the acceptable risk range if interpreted as $1x10^{-6}$ to $1x10^{-4}$, this calculated
risk is within EPA's discretionary interpretation of the NCP risk range (10^{-6} to 10^{-4}). The
total estimated cancer risk range for children who consume hard clam caught by adult
anglers ($7x10^{-5}$) is within EPA's acceptable risk range. The total non-cancer HQ for
adult anglers consuming hard clam (1) is at EPA's threshold of unity while the total non-
cancer HQ for children (2) is above EPA's threshold of unity.

Arsenic samples used in the risk assessment were not speciated. As a result, it was conservatively assumed that 100% of the detected arsenic was in the more toxic, inorganic form. The next step in the risk assessment process was to reevaluate the risks using more realistic (and less conservative) assumptions regarding the form of arsenic likely found in tissue. EPA performed a literature search to estimate a typical range in biota tissue. A majority of the scientific literature indicates that inorganic arsenic in finfish and shellfish is generally less than 10% of the total arsenic concentration, sometimes much lower. Donahue & Abernathy (1999) indicated that organic arsenic is generally greater than 90% (inorganic <10%) of the total arsenic. Greene & Crecelius (2006) investigated levels of inorganic arsenic in finfish and shellfish of the Delaware estuary and found that the mean percentage of inorganic to total arsenic in summer flounder was 0.7% and in hard clam was 1.1%. The greatest percentage of inorganic arsenic was found in the croaker (1.7%), which was not one of the species analyzed at the Site. One study, Lorenzara et al. (2009), indicated again that inorganic arsenic is generally less than 10% but can range up to nearly 30% in contaminated areas.

In order to introduce more realistic assumptions regarding the percentage of inorganic arsenic, but still keeping in mind the goal of protection of human health, EPA assumed the high end literature value of 30% inorganic arsenic to quantitatively evaluate arsenic in fish and hard clam at the site. The EPA online screening level calculator (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) was used to estimate a total arsenic concentration that corresponds with 30% inorganic arsenic for fish and hard clam.

For fish, using an HQ of 1 and a cancer risk of 10^{-4} results in an inorganic arsenic screening level of 0.41 mg/kg for adults (cancer driving risk) and children (cancer and non-cancer equally driving risk). Assuming that this quantity represents 30% of the total arsenic in fish tissue, a concentration of 1.4 mg/kg was calculated as the total arsenic screening level. In the risk assessment, the maximum concentration was used as the exposure point concentration because less than 10 samples were collected and summary statistics could not reliably be calculated. The maximum arsenic concentration in fish was 0.68 mg/kg, below the health-protective screening level of 1.4 mg/kg. As a result, EPA does not believe that ingestion of arsenic in the fish poses an unacceptable human health risk.

For hard clam, using an HQ of 1 and a cancer risk of 10^{-4} results in an inorganic arsenic screening level of 0.85 mg/kg for adults (cancer driving risk) and children (cancer and non-cancer equally driving risk). Assuming that this quantity represents 30% of the total arsenic in hard clam tissue, a concentration of 2.8 mg/kg was calculated as the total arsenic screening level. In the risk assessment, the maximum concentration was used as the exposure point concentration because less than 10 samples were collected and summary statistics could not reliably be calculated. The maximum arsenic concentration in hard clam was 1.6 mg/kg, below the health-protective screening level of 2.8 mg/kg. As a result, EPA does not believe that ingestion of arsenic in the hard clam poses an unacceptable human health risk.

<u>Unacceptable Risks from Groundwater</u>

Unacceptable risks to future adult/child residents consuming groundwater as drinking water at the Raritan Bay Slag site were demonstrated in the risk assessment. Unacceptable risks were due to the presence of both cobalt (HI=5) and iron (HI=7). This analysis provides lines of evidence to conclude that both cobalt and iron are likely not present due to the site-related slag, and that concentrations of these two chemicals throughout the site are likely present due to natural geochemical conditions.

Cobalt concentrations in groundwater at 21 wells sampled across the site ranged from 0.38 µg/L to 40.1 µg/L. None of the 21 wells exceeded the NJ Groundwater Quality Standard Class IIA Interim Specific Groundwater Quality Criteria for cobalt in fresh groundwater of 100 ug/L. Several lines of evidence indicate that site-related source material has not contributed to the cobalt concentrations and that the elevated groundwater concentrations result mostly from existing geochemical conditions in the area, including:

a) Cobalt is detectable at low concentrations in groundwater at wells located throughout the site, even in areas where no source material is present.
b) The presence of slag at the site is not directly correlated to groundwater cobalt concentrations.
c) The cobalt concentrations in groundwater are not directly correlated to groundwater samples with exceedences of criteria by other metals associated with slag.
d) Cobalt was not detected at significant levels in samples analyzed during the Slag Characterization Study conducted by Schnabel (0.0% relative percent).

Iron is a naturally occurring element found in soils of New Jersey and is commonly observed in groundwater above criteria. Elevated iron concentrations in groundwater were observed in several wells at the site, but the most highly affected wells are located in the vicinity or down-gradient of wetland areas. Although site-related slag material could have contributed some iron, several lines of evidence indicate that the elevated groundwater concentrations result mostly from existing geochemical conditions at the site. The concentrations of iron in groundwater at the 21 wells sampled across the site varied significantly, ranging from 64.2 µg/L to 372,000 µg/L. The site-specific groundwater background concentration for iron from up-gradient well MW-11S is 4,980 µg/L, indicating that iron is naturally occurring at a significant level.

Six wells exceeded the EPA Regional Screening Level (RSL) for iron in tapwater of 11,000 µg/L; MW-2S in Area 6, MW-8S and MW-10D in Area 4, and MW-12S, MW-13S, and MW14S in Area 9. These six wells are located in the vicinity or down-gradient of wetlands and are in areas with iron concentrations in soil that are within the regional background concentration. The decay of organic material in wetlands can cause reducing conditions in the groundwater. A significant part of the concentrations of iron exceeding

the EPA RSL in groundwater are most likely related to the dissolution of iron oxyhydroxides in soil and the reducing conditions associated with groundwater in the wetlands. Although iron oxyhydroxide is typically stable or insoluble in water, it becomes soluble under reducing and low pH conditions. Negative values for redox potential (suggesting reducing conditions) were measured at five of these six wells.

The presence of slag at the site is not directly correlated to groundwater that exceeds the screening level for iron. For example, iron concentrations in the wells located close to the slag of the Western Jetty (MW-1S and MW-1D) were below the site-specific background. Wells MW-5S, MW-5D, MW-6S, MW-6D are near slag on the seawall and had iron concentrations greater than the EPA secondary maximum contaminant levels (http://water.epa.gov/drink/contaminants/secondarystandards.cfm), but groundwater did not exceed the EPA RSL.

These lines of evidence provide a scientific basis to support the conclusion that iron in the groundwater is a result of the geochemical characteristics of the site and the influence of the wetlands, rather than from the slag.

While arsenic in groundwater did not pose an unacceptable human health risk, it does exist above ARARs. Arsenic concentrations in groundwater at 21 wells sampled across the site ranged from 0.45 µg/L to 6.8 µg/L. Groundwater samples from five of the 21 wells exceeded the arsenic criterion for NJGWQS Class IIA fresh groundwater of 3 ug/L. Several lines of evidence indicate that site-related source material has not contributed to the arsenic concentrations and that the slightly elevated groundwater concentrations likely result mostly from existing geochemical conditions in the area.

a) The site-specific groundwater background concentration for arsenic from upgradient well MW-11S is 4.2 µg/L, indicating that arsenic is naturally occurring at a level above the criterion for NJGWQS Class IIA fresh groundwater.
b) The maximum concentration of arsenic observed in the site groundwater samples was 6.8 ug/L, and suggests that source materials are not creating a groundwater arsenic plume.
c) Arsenic is detectable at low concentrations in groundwater at wells located throughout the site, even in areas where no source material is present.
d) The presence of slag at the site is not directly correlated to groundwater arsenic concentrations. Several wells located by the source materials do not have groundwater that exceeds the NJDEP groundwater screening criterion.
e) The arsenic concentrations in groundwater are not directly correlated to groundwater samples that have exceedences of criteria by other metals.

As mentioned above, several monitoring wells across the site have contained naturally-occurring concentrations of cobalt, iron and/ or arsenic that are impacting groundwater quality as a result of background or geochemical conditions. During the drafting of this memorandum, NJDEP provided concurrence that the Class III-B classification for groundwater in the area containing monitoring wells MW-07S-R1, MW08D-R1, MW-08S-R1, MW-09S-R1, MW-10D-R1, MW-10S-R1, and MW-12S-R1 applies (see

attached Figure). Based on the Class III-B reclassification, drinking water wells cannot be drilled and Applicable, or Relevant and Appropriate Requirements (ARARs) no longer apply to groundwater in the affected area. Groundwater is not currently used for drinking water at the site. Future potable use of groundwater in the Class III-B reclassification area is prohibited and in the remainder of the site is highly unlikely because of high salinity and the available municipal water system which nearby residences currently use to obtain drinking water.

References

Donahue, J.M. and C.O. Abernathy, 1999. *Exposure to Inorganic Arsenic from Fish and Shellfish.* In: Chappell W.R., Abernathy C.O., Calderon R.L. (eds): Arsenic Exposure and Health Effects, Elsevier Science BV, New York, pp. 89-98.

Greene, R. and E. Crecelius, 2006. *Total and Inorganic Arsenic in Mid-Atlantic Marine Fish and Shellfish and Implications for Fish Advisories.* Integrated Environmental Assessment and Management, Vol. 2, No. 4, pp. 344-354.

Lorenzara, R., et al., 2009. *Arsenic in Seafood: Speciation Issues for Human Health Risk Assessment.* Human and Ecological Risk Assessment, Vol. 15, No. 1, pp. 185-200 (16).

Area 8 · Area 7 · Area 6 · Area 2 · Area 1 · Area 3 · Area 9 · Area 10

Well locations: MW-01S, MW-01D, MW-02S, MW-03S, MW-06S, MW-06D, MW-05S, MW-05D, MW-04S, MW-04D, MW-10S, MW-10D, MW-09S, MW-08S, MW-08D, MW-07S, MW-11S, MW-12S, MW-13S, MW-14S, MW-15S

MW-01S — 1/5/2011

Chemical Name	Result	Qualifier
Aluminum	1510	J+
Arsenic	3.4	
Beryllium	0.095	J
Chromium	7.2	
Iron	3430	
Lead	5.5	
Manganese	45.9	
Nickel	3.1	
Sodium	2530000	
Tetrachloroethene	0.4	U

MW-01D — 1/5/2011

Chemical Name	Result	Qualifier
Aluminum	16.3	J
Arsenic	0.46	
Beryllium	2	U
Chromium	0.76	
Iron	64.2	J
Lead	0.4	J
Manganese	2.7	J
Nickel	2	
Sodium	4110000	
Tetrachloroethene	0.4	U

MW-02S — 1/6/2011

Chemical Name	Result	Qualifier
Aluminum	969	J
Arsenic	3.8	J
Beryllium	1	U
Chromium	5.3	
Iron	28500	
Lead	1.8	
Manganese	1560	J
Nickel	3.5	
Sodium	805000	
Tetrachloroethene	0.4	U

MW-03S — 1/6/2011

Chemical Name	Result	Qualifier
Aluminum	1120	J
Arsenic	1.1	J
Beryllium	1	U
Chromium	27.3	
Iron	1470	
Lead	2.3	
Manganese	11.6	J
Nickel	12.6	
Sodium	18700	
Tetrachloroethene	0.4	U

MW-06S — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	3900	
Arsenic	0.93	
Beryllium	5.7	
Chromium	4	
Iron	676	
Lead	3.4	
Manganese	499	
Nickel	29	
Sodium	71600	
Tetrachloroethene	0.4	U

MW-06D — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	8360	
Arsenic	2.3	
Beryllium	1.4	
Chromium	8.2	
Iron	9200	
Lead	8.5	
Manganese	468	
Nickel	20.2	
Sodium	502000	
Tetrachloroethene	0.4	U

MW-05S — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	6980	
Arsenic	1.6	
Beryllium	6.2	
Chromium	4.3	
Iron	10200	
Lead	5.6	
Manganese	690	
Nickel	28.1	
Sodium	66300	
Tetrachloroethene	0.4	U

MW-05D — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	418	
Arsenic	0.72	
Beryllium	0.15	J
Chromium	5.3	
Iron	625	
Lead	3.7	
Manganese	156	
Nickel	8.3	
Sodium	44600	
Tetrachloroethene	0.4	U

MW-10S

Sample Date	Chemical Name	Result	Qualifier
1/5/2011	Aluminum	2160	
	Arsenic	0.86	
	Beryllium	0.48	J
	Chromium	3	
	Iron	213	
	Lead	107	
	Manganese	608	
	Nickel	25	
	Sodium	4420000	
	Tetrachloroethene	3.8	
4/6/2011	Aluminum	1210	
	Arsenic	10	
	Beryllium	0.58	J
	Chromium	10	
	Iron	214	
	Lead	36.6	
	Manganese	271	
	Nickel	19.9	
	Sodium	2440000	
	Tetrachloroethene	Not measured	

MW-10D

Sample Date	Chemical Name	Result	Qualifier
1/5/2011	Aluminum	1180	
	Arsenic	2.1	
	Beryllium	0.36	J
	Chromium	23.8	
	Iron	84300	
	Lead	18.1	
	Manganese	2060	
	Nickel	52.3	
	Sodium	158000	
	Tetrachloroethene	0.4	U
4/6/2011	Aluminum	4670	J
	Arsenic	6.6	
	Beryllium	1.9	
	Chromium	162	
	Iron	83200	
	Lead	79.5	
	Manganese	814	
	Nickel	214	
	Sodium	115000	J
	Tetrachloroethene	Not measured	

MW-12S — 1/6/2011

Chemical Name	Result	Qualifier
Aluminum	887	J
Arsenic	1.5	J
Beryllium	1	U
Chromium	4.8	J
Iron	372000	
Lead	20.4	
Manganese	1840	
Nickel	9.4	
Sodium	1020000	
Tetrachloroethene	0.4	U

MW-09S — 1/5/2011

Chemical Name	Result	Qualifier
Aluminum	9020	
Arsenic	1.8	
Beryllium	2.1	
Chromium	5.4	J
Iron	1310	
Lead	6.6	
Manganese	1510	
Nickel	37.5	
Sodium	331000	
Tetrachloroethene	0.54	

MW-08S — 1/5/2011

Chemical Name	Result	Qualifier
Aluminum	3460	
Arsenic	1.2	
Beryllium	1.7	
Chromium	5.5	
Iron	35800	
Lead	1.2	
Manganese	1480	
Nickel	37.3	
Sodium	43100	
Tetrachloroethene	5.3	

MW-08D — 1/5/2011

Chemical Name	Result	Qualifier
Aluminum	10600	J+
Arsenic	1.2	
Beryllium	1.6	
Chromium	5.2	J
Iron	5300	
Lead	3.9	
Manganese	1720	
Nickel	35.2	
Sodium	1230000	
Tetrachloroethene	1.3	

MW-07S — 1/5/2011

Chemical Name	Result	Qualifier
Aluminum	887	
Arsenic	0.63	
Beryllium	0.46	J
Chromium	8.6	
Iron	167	
Lead	1.5	
Manganese	493	
Nickel	15.6	
Sodium	64700	
Tetrachloroethene	0.4	U

MW-13S — 1/6/2011

Chemical Name	Result	Qualifier
Aluminum	108	J
Arsenic	6.8	J
Beryllium	1	U
Chromium	2	
Iron	38500	
Lead	9	
Manganese	1550	J
Nickel	3.6	
Sodium	123000	
Tetrachloroethene	0.4	U

MW-14S — 1/6/2011

Chemical Name	Result	Qualifier
Aluminum	2920	J
Arsenic	6.4	J
Beryllium	1	U
Chromium	23.5	
Iron	44300	
Lead	9	
Manganese	369	J
Nickel	10.5	
Sodium	806000	
Tetrachloroethene	0.4	U

MW-04S — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	757	
Arsenic	0.45	
Beryllium	0.98	J
Chromium	6.2	
Iron	73	
Lead	1.5	
Manganese	158	
Nickel	14.8	U
Sodium	55100	
Tetrachloroethene	0.4	U

MW-04D — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	768	
Arsenic	1.2	
Beryllium	0.42	J
Chromium	7.6	
Iron	854	
Lead	4.2	
Manganese	190	
Nickel	10.5	
Sodium	47900	
Tetrachloroethene	0.4	U

MW-11S — 1/4/2011

Chemical Name	Result	Qualifier
Aluminum	1610	
Arsenic	4.2	J
Beryllium	0.24	J
Chromium	49.9	
Iron	4980	
Lead	7.3	
Manganese	31.4	
Nickel	11.2	
Sodium	64800	
Tetrachloroethene	0.4	U

MW-15S — 1/6/2011

Chemical Name	Result	Qualifier
Aluminum	34800	J
Arsenic	1.6	J
Beryllium	2	
Chromium	9.3	
Iron	8760	
Lead	6.2	
Manganese	266	J
Nickel	52.5	
Sodium	6240	
Tetrachloroethene	0.4	U

Screening Criteria

Chemical Name	Screening Criteria
Aluminum	200
Arsenic	3
Beryllium	1
Chromium	70
Iron	300
Lead	5
Manganese	50
Nickel	100
Sodium	50000
Tetrachloroethene	1

Legend

Monitoring Well Locations
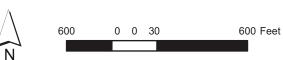
EPA

Notes:
All units in µg/L.
Results exceeding screening criteria are highlighted.
Antimony, chromium and copper do not exceed screening criteria in wells sampled.
J: Estimated concentration.
J+: Estimated concentration is biased high.
U: Compound was analyzed for but not detected.

N

600   0   0   30   600 Feet

Figure 1-21
Groundwater Sampling Results
Raritan Bay Slag Superfund Site
Old Bridge/Sayreville, New Jersey

R2–0015261